

Final

**INCREASED OIL PRODUCTION AND RESERVES  
UTILIZING SECONDARY/TERTIARY RECOVERY  
TECHNIQUES ON SMALL RESERVOIRS  
IN THE PARADOX BASIN, UTAH  
(Contract No. DE-FC22-95BC14988)**

**TECHNICAL PROGRESS REPORT**

*Submitted by*

**Utah Geological Survey**  
Salt Lake City, Utah 84114-6100  
January 2002



**Contract Date:** February 9, 1995  
**Anticipated Completion Date:** August 31, 2005  
**Government Award (fiscal year):** \$137,072  
**Principal Investigator/Program Manager:** Thomas C. Chidsey, Jr.

Contracting Officer's Representative/Project Manager

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**Reporting Period:** October 1 - December 31, 2001

US/DOE Patent Clearance is not required prior to the publication of this document.

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Contracting Officer's Representatives: Gary D. Walker/Dan Ferguson, National Petroleum Technology Office, Tulsa, Oklahoma

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## **Objectives**

The primary objective of this project is to enhance domestic petroleum production by demonstration and technology transfer of an advanced oil recovery technology in the Paradox Basin, southeastern Utah. If this project can demonstrate technical and economic feasibility, the technique can be applied to about 100 additional small fields in the Paradox Basin alone, and result in increased recovery of 150 to 200 million bbl of oil. This project is designed to characterize five shallow-shelf carbonate reservoirs in the Pennsylvanian (Desmoinesian) Paradox Formation and choose the best candidate for a pilot demonstration project for either a waterflood or carbon dioxide- (CO<sub>2</sub>-) flood project. The field demonstration, monitoring of field performance, and associated validation activities will take place in the Paradox Basin within the Navajo Nation. The results of this project will be transferred to industry and other researchers through a petroleum extension service, creation of digital databases for distribution, technical workshops and seminars, field trips, technical presentations at national and regional professional meetings, and publication in newsletters and various technical or trade journals.

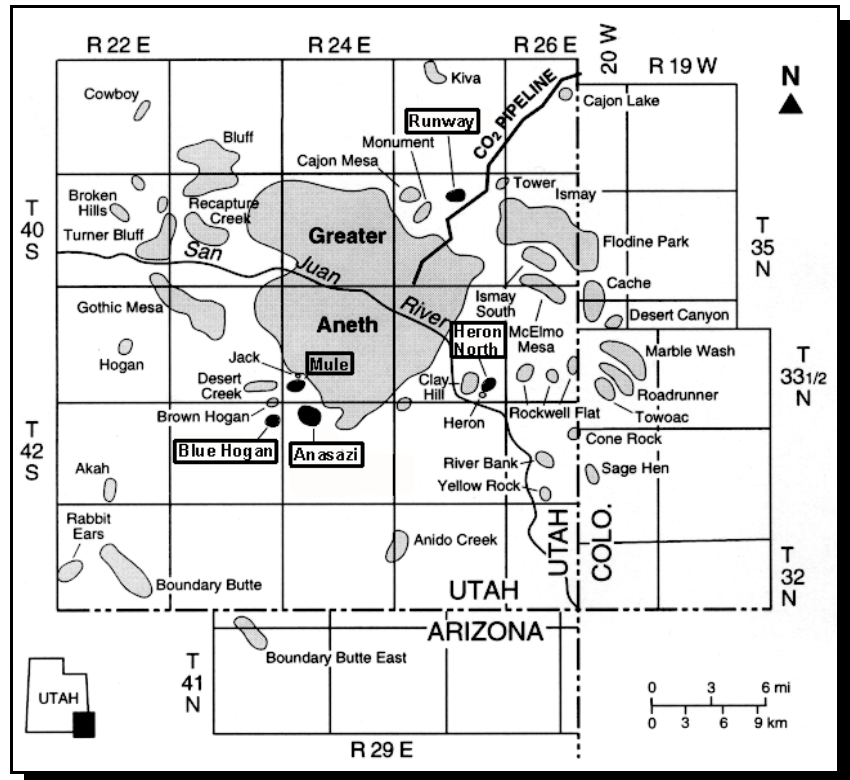
## Summary of Technical Progress

### *Implementation of Pilot Carbon Dioxide Flood Demonstration*

Results from Budget Period I of this project showed that a carbon dioxide (CO<sub>2</sub>) flood was technically superior to a waterflood and was economically feasible on typical small, shallow-shelf carbonate buildup reservoirs in the Paradox Basin.<sup>1,2</sup> Based on the geologic characterization study, reservoir performance predictions, and the associated economic assessment of implementing a CO<sub>2</sub> flood in the Anasazi field, San Juan County, Utah (Fig. 1), an optimized CO<sub>2</sub> flood is predicted to recover 4.21 million STB of oil. This represents an increase of 1.65 million STB of oil over predicted primary depletion recovery at January 1, 2012. If the CO<sub>2</sub> flood performs as predicted, it is a financially robust process for increasing the reserves of the Anasazi field and similar small fields in the basin.

Budget Period II of the project involves the implementation of a pilot CO<sub>2</sub>-flood demonstration on Anasazi field. The field demonstration includes: conducting a CO<sub>2</sub> injection test(s), obtaining a CO<sub>2</sub> source and fuel gas for the compressor, rerunning project economics, drilling a development well(s) (vertically or horizontally), purchasing and installing injection facilities, monitoring field performance, and validation and evaluation of the techniques. The demonstration will prove (or disprove) CO<sub>2</sub>-flood viability, and thus help determine whether the technique can be applied to the other small carbonate buildup reservoirs in the Paradox Basin. Obtaining a CO<sub>2</sub> source is the key to beginning this demonstration.

At this time, there is only one CO<sub>2</sub> source in the area, a pipeline (Fig. 1) which is now owned and operated by ExxonMobil (formerly Mobil Oil Corporation). The CO<sub>2</sub> line is currently operating at full capacity supplying CO<sub>2</sub> to wells on the north side of the San Juan River as part of a large CO<sub>2</sub> flood of the giant Greater Aneth field. In 2000, 15.5 BCF of CO<sub>2</sub> was injected into the Desert Creek reservoir (Paradox Formation) in the field.<sup>3</sup> During the year, monthly injection of CO<sub>2</sub> averaged 0.4



**Figure 1. Location of Anasazi field (dark shaded area with name in bold type) and CO<sub>2</sub> pipeline to the Greater Aneth field area in the southwestern Paradox Basin on the Navajo Nation, San Juan County, Utah.**

BCF. Plans to expand the pipeline capacity and extend it to Greater Aneth wells south across the river, and thus closer to Anasazi field, were delayed about a year and a half due to low oil prices in 1998 and early 1999, and a backlog of higher priority projects of the Greater Aneth field operators. These factors, combined with uncertainty related to the merger of Mobil and Exxon, and current low oil prices, have delayed the availability of CO<sub>2</sub> for the Anasazi field demonstration for at least three years. However, the pipeline has now been extended south of the San Juan River to other parts of Greater Aneth field and further expansion is in the planning stages.

All project fields (Anasazi, Blue Hogan, Heron North, Mule, and Runway; Fig. 1) operated by the Utah Geological Survey's industry partner, Harken Energy Corporation, have been sold to the Rim Energy Companies of Denver, Colorado. However, the Utah Geological Survey still desires to see the project completed through the demonstration phase, and has established contact with the Rim Energy Companies. A meeting between Rim Energy and project team members in Denver to review the project results and objectives occurred on September 11, 2001. Due to the tragic events of that day, Tom Chidsey, the Principal Investigator, was unable to fly to the meeting from Salt Lake City. He will meet separately with Rim Energy at a later date to determine their interest in continuing the pilot demonstration. In addition, Exxon/Mobil has expressed interest in working with Rim to tie Anasazi field into their CO<sub>2</sub> pipeline infrastructure and negotiations have begun.

The Utah Geological Survey will continue to carefully monitor the CO<sub>2</sub> availability situation. Several operators of other fields in the Paradox Basin similar to Anasazi have expressed interest in the technique and would consider conducting the CO<sub>2</sub>-flood project if problems prevent the demonstration from occurring at Anasazi field. Most operators in the basin are small independent companies that need to see a successful and economically viable CO<sub>2</sub>-flood demonstrated on a small field before they will invest in CO<sub>2</sub> acquisition, new pipelines, injection wells, and additional field facilities.

### ***Technology Transfer***

The project home page on the UGS Internet web site (<http://geology.utah.gov/emp/PARADOX/index.htm>) was updated with the latest quarterly technical report and project publications list.

### **References**

1. T. C. Chidsey, Jr., and M. L. Allison, Increased Oil Production and Reserves Utilizing Secondary/Tertiary Recovery Techniques on Small Reservoirs in the Paradox Basin, Utah, *Annual Report*, DOE Contract No. DE-FC22-95BC14988, DOE/BC/14988-10 (DE98000493), July 1998.
2. T. C. Chidsey, Jr., D. E. Eby, D. M. Lorenz, and W. E. Culham, Increased Oil Production and Reserves Utilizing Secondary/Tertiary Recovery Techniques on Small Reservoirs in the Paradox Basin, Utah, *Annual Report*, DOE Contract No. DE-FC22-95BC14988, DOE/BC/14988-12 (OSTI ID: 14245), November 1999.
3. Lisha Cordova, 2002, *Utah Annual Injection Report 2000*, Utah Division of Oil, Gas and Mining, in preparation.

## **Next Quarter Activities**

Activities planned for the next quarter (January 1 through March 31, 2002) include:

1. Meet with the Rim Energy Companies to review the project and determine their interest in continuing the pilot demonstration project. Exxon/Mobil to be included via conference call.
2. Monitor CO<sub>2</sub> availability for Anasazi field pilot flood project.
3. Continue preparation of a digital catalog of basic pore types and report of diagenetic history of reservoirs based on thin sections from project fields.
4. Update project home page on the UGS Internet web site.